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Indian Standard
METHODS OF CHEMICAL ANALYSIS OF COPPER-NICKEL-ZINC ALLOYS

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 4 *October* 1965

Indian Standard
METHODS OF CHEMICAL ANALYSIS OF COPPER-NICKEL-ZINC ALLOYS

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Indian Standard
METHODS OF CHEMICAL ANALYSIS OF COPPER-NICKEL-ZINC ALLOYS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 1 August 1965, after the draft finalized by the Methods of Chemical Analysis Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 With the formulation of Indian Standards on copper-nickel-zinc alloys recently, need was felt to prescribe standard methods to analyse these alloys. These methods have been prepared with a view that they shall be useful as reference methods.

0.3 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country. This has been met by deriving assistance from the following publications:

FURMAN (N H) *Ed.* and SCOTT (W W), Standard methods of chemical analysis. 1948. Ed 5. D. Van Nostrand Company, Inc., New York

LUNDELL (G E F), HOFFMAN (J I) AND BRIGHT (H F). Chemical analysis of iron and steel. 1946. John Wiley and Sons, Inc., New York

1962 Book of ASTM methods for chemical analysis of metals. American Society for Testing and Materials.

0.4 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS: 2-1960*.

1. SCOPE

1.1 This standard prescribes methods for determination of copper, lead, nickel, iron, manganese, zinc and carbon in the ranges specified in the relevant Indian Standard specifications on copper-nickel-zinc alloys.

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*Rules for rounding off numerical values (*revised*).

2. SAMPLING

2.1 Samples shall be drawn and prepared in accordance with IS : 1817-1961*.

3. QUALITY OF REAGENTS

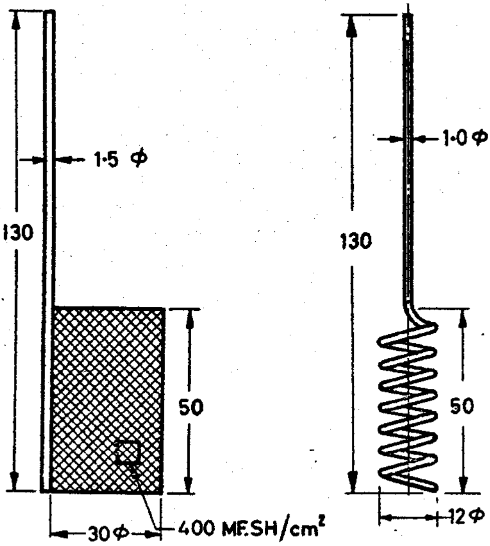
3.1 Unless specified otherwise, pure chemicals and distilled water (*see* IS : 1070-1961†) shall be used.

NOTE — 'Pure chemicals' shall mean chemicals that do not contain impurities which affect the results of analysis.

4. DETERMINATION OF COPPER AND LEAD BY ELECTROLYTIC METHOD

4.1 Outline of the Method — The sample is dissolved in nitric acid and copper and lead are electrolytically deposited and copper weighed. As the weight of lead peroxide is too small for weighing, lead is estimated colorimetrically as sulphide in presence of sucrose.

4.2 Electrodes — The following platinum electrodes (*see* Fig. 1) are recommended but strict adherence to the shape and size of the electrode is not essential. For agitation of electrolyte in order to decrease the time of deposition, one of the types of rotating forms of electrodes, generally available, may be employed.



1A Cylindrical Platinum Cathode 1B Spiral Platinum Anode

All dimensions in millimetres.

FIG. 1 CYLINDRICAL PLATINUM CATHODE AND SPIRAL PLATINUM ANODE

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*Methods of sampling non-ferrous metals for chemical analysis.

†Specification for water, distilled quality (*revised*).

4.2.1 *Cathode* — It may be formed either from plain or from perforated sheet or from wire gauze.

4.2.1.1 Gauze cathodes preferably made from gauze containing 400 mesh/cm^2 should be used. The wire used for making gauze should be approximately 0·20 mm in diameter. Cathodes should be stiffened by doubling the gauze for about 3 mm on the top and the bottom or by reinforcing the gauze at the top and bottom with platinum ring or band.

4.2.1.2 The diameter of the cylinder should be approximately 30 mm and the height 50 mm. The stem should be made from platinum alloy wire such as platinum-iridium, platinum-rhodium or platinum-ruthenium having diameter of approximately 1·5 mm. It should be flattened and welded throughout the entire length of the gauze. The overall height of the cathode should be approximately 130 mm.

4.2.2 *Anode* — As the amount of lead in the sample (*see* **4.4.1**) is less than 4 mg a spiral anode should be used. It should be made from 1·0 mm or larger platinum wire formed into spiral of seven turns with a height of approximately 50 mm and diameter of 12 mm, the overall height being 130 mm.

4.3 Reagents

4.3.1 *Dilute Nitric Acid* — 1 : 1 (*v/v*).

4.3.2 *Dilute Hydrochloric Acid* — 0·1 N approximately.

4.3.3 *Urea* — solid.

4.3.4 *Hydrogen Sulphide Solution* — saturate dilute sulphuric acid (1 : 99) with hydrogen sulphide gas.

4.3.5 *Rectified Spirit* — 95 percent (*v/v*) (conforming to IS : 323-1959*) and dilute, 1 : 1 (*v/v*).

4.3.6 *Acidified Hydrogen Sulphide Solution* — in one percent hydrochloric acid.

4.3.7 *Hydrogen Peroxide Solution* — 3 percent.

4.3.8 *Ammonium Acetate Solution* — Dissolve 23 g of ammonium acetate in water, and 3 ml of glacial acetic acid and dilute to 100 ml (approximately 3 N).

4.3.9 *Sucrose Solution* — 50 percent (*w/v*).

4.3.10 *Standard Lead Acetate Solution* — (1 ml = 0·000 1 g of lead). Dissolve 0·183 1 g of lead acetate [$Pb(C_2H_3O_2)_2, 3H_2O$] in water containing a little acetic acid and dilute to one litre.

---

*Specification for rectified spirit (*revised*).

4.4 Procedure

4.4.1 Dissolve 5 grams of an accurately weighed sample in 40 ml of dilute nitric acid. Heat on a steam bath and boil to expel brown fumes. Dilute the solution to 200 ml and add one drop of dilute hydrochloric acid. Add two grams of urea. Insert the electrodes, cover the beaker with split watch glasses. Electrolyse overnight with a current of 0·5 A/dm^2 and without agitation or with a current of 2 to 3 A/dm^2 using gauze cathode and rotating agitator for about two and a half hours. When the solution is colourless, wash down the watch glasses, electrodes and sides of the beaker, raising the level of liquid slightly; continue passing the current noting whether or not copper is being plated on the newly exposed surface of platinum. If no copper appears, transfer about one millilitre of the solution to a spot plate and add a few drops of freshly prepared acidified hydrogen sulphide solution. If the slightest discolouration takes place, continue electrolysis until it is nearly complete.

4.4.2 As soon as the deposition is complete, without stopping the current lower the beaker slowly while washing the cathode at the same time. Remove the cathode quickly, rinse with water and then dip in two successive baths of rectified spirit Dry for 3 to 5 minutes in an oven at 105° to 110°C, cool and weigh the deposit immediately as metallic copper. Dry the anode in a oven at 110° to 120°C for 30 minutes; the deposit being fragile should be handled with care. Cool the anode.

4.4.3 *Calculation*

$$\text{Copper, percent} = \frac{A}{B} \times 100$$

where

A = weight in g of the copper deposit, and

B = weight in g of the sample taken.

4.4.4 Dissolve the lead peroxide on the anode (*see* **4.4.2**) in 5 ml of dilute nitric acid. Add a few drops of hydrogen peroxide solution or rectified spirit. Evaporate to dryness and take up with water. Cool, transfer to a 100-ml graduated flask, dilute to the mark and mix well. Pipette a suitable aliquot portion of this solution into 100-ml Nessler tube, add 6 ml of ammonium acetate solution, 3 drops of dilute nitric acid, one millilitre of sucrose solution and finally 50 ml of water. Add 5 ml of freshly prepared acidified hydrogen sulphide solution, mix well.

4.4.5 Take a measured volume of a standard lead acetate solution to which ammonium acetate solution, dilute nitric acid (1 : 1), sucrose solution and acidified hydrogen sulphide solution, have been added in the same quantities as in the test solution. Finally dilute the standard solution and the test solution to the same volume and compare in a suitable type of colorimeter. It is important to add the acidified hydrogen sulphide solution simultaneously to the standard and test solutions.

4.4.6 *Calculation*

$$\text{Lead, percent} = \frac{A \times H_1}{H_2} \times 0{\cdot}000\,1 \times \frac{100}{B}$$

where

A = volume in ml of the standard lead acetate solution used,
H_1 = height of column of standard lead acetate solution,
H_2 = height of column of test solution, and
B = weight in g of the sample taken.

5. DETERMINATION OF NICKEL BY THE DIMETHYLGLYOXIME (GRAVIMETRIC) METHOD

5.1 Outline of the Method — After removal of copper by electrolysis, nickel is precipitated by dimethylglyoxime, filtered, dried and weighed.

5.2 Reagents

5.2.1 *Dilute Nitric Acid* — 1 : 1 (*v/v*).

5.2.2 *Tartaric Acid Solution* — Dissolve 250 g of tartaric acid in water and dilute to one litre.

5.2.3 *Concentrated Ammonium Hydroxide* — 20 percent.

5.2.4 *Dimethylglyoxime Solution* — Dissolve ten grams of dimethylglyoxime in one litre of rectified spirit (conforming to IS : 323-1959*) and filter before using.

5.3 Procedure

5.3.1 Take one gram of accurately weighed sample, dissolve in 25 ml of dilute nitric acid and remove the copper by the electrolytic method as described under **4.4**. Transfer the solution to a 250-ml volumetric flask. Dilute the solution and washings to the mark and after mixing take a suitable aliquot containing 50 to 100 g of nickel. Dilute to 100 to 300 ml and add 10 ml of tartaric acid solution. Neutralize with concentrated ammonium hydroxide and add one millilitre in excess. The solution should remain clear after this treatment. Heat at 70°C and add 0·4 ml of dimethylglyoxime solution for each one milligram of nickel present and add 5 to 10 ml in excess, pouring directly into the solution and not down the beaker wall. Stir the mixture vigorously and allow to cool to room temperature with occasional stirring. Filter through a sintered glass crucible of medium porosity and wash well with water. Dry the precipitate to constant weight at 150°C and weigh as nickel dimethylglyoxime.

---

*Specification for rectified spirit (*revised*).

5.4 Calculation

$$\text{Nickel, percent} = \frac{A}{B} \times 20{\cdot}32$$

where

A = weight in g of nickel dimethylglyoxime, and
B = weight in g of the sample taken.

6. DETERMINATION OF IRON BY THE DICHROMATE (VOLUMETRIC) METHOD

6.1 Outline of the Method — Iron is reduced in a boiling solution with stannous chloride, the excess of which is destroyed with mercuric chloride. The reduced iron is titrated with standard potassium dichromate solution using sodium diphenylamine sulphonate as internal indicator.

6.2 Reagents

6.2.1 *Dilute Nitric Acid* — 1 : 1 (*v/v*).

6.2.2 *Concentrated Ammonium Hydroxide* — 20 percent.

6.2.3 *Ammonium Chloride Solution* — 20 g/l (*w/v*).

6.2.4 *Stannous Chloride Solution* — Dissolve by heating 60 g of pure stannous chloride in a mixture of 400 ml of concentrated hydrochloric acid and 600 ml of water until the solution is complete. Cool, add a few pieces of granulated tin and preserve the solution in an air-tight amber-coloured bottle to prevent oxidation.

6.2.5 *Mercuric Chloride Solution* — Prepare a saturated solution of mercuric chloride in water.

6.2.6 *Sulphuric-Phosphoric Acid Mixture* — Add slowly 150 ml of concentrated sulphuric acid to 700 ml of water with continuous stirring. Add to this 150 ml of syrupy phosphoric acid. Destroy any oxidizable impurities by adding potassium permanganate solution (0·1 N) drop by drop until the pink colour of permanganate persists; and cool the solution.

6.2.7 *Sodium Diphenylamine Sulphonate Indicator Solution* — Dissolve 0·32 g of barium diphenylamine sulphonate in 100 ml of hot water. Add 0·5 g of sodium sulphate, stir, and filter off the precipitate of barium sulphate. Store in a dark-coloured bottle.

6.2.8 *Standard Potassium Dichromate Solution* — 0·05 N. Dry pure potassium dichromate in an oven at 105° to 110°C for one and a half hours.

Cool in a desiccator and transfer exactly 2·451 g to a one-litre volumetric flask carefully through a funnel using water at room temperature. Wash the funnel thoroughly and dissolve the salt by shaking until the solution is complete. Make up to the mark and mix well. Preserve the solution in an amber-coloured bottle.

6.3 Procedure

6.3.1 Dissolve five grams of accurately weighed sample free from adventitious iron in 50 ml of dilute nitric acid in a 250-ml beaker and heat to expel brown fumes. Adjust the volume of the solution to 150 ml and add concentrated ammonium hydroxide until slightly but distinctly alkaline. Boil for a few minutes and allow to settle for some time. Filter while hot, using a medium-texture paper and wash a few times alternately with ammonium chloride solution and hot water. Dissolve the precipitate through the filter paper with 20 ml of hot dilute hydrochloric acid and wash thoroughly with hot water, collecting the solution and washings in the original beaker. Evaporate the solution to 15 to 20 ml. Heat to boiling and to the boiling solution add stannous chloride solution drop by drop with continuous stirring until the solution just becomes colourless. Add two to three drops excess of stannous chloride solution and wash down the sides with a little water. Cool the flask rapidly under running tap water until the contents have cooled down to room temperature.

6.3.2 Add excess of mercuric chloride solution (about five millilitres) and shake the flask. At this stage a silky white precipitate appears. If it fails to appear or if a blackish precipitate appears, reject the test. If the precipitate is too much, add further 5 millilitres of mercuric chloride solution. Keep for about two to five minutes and add 15 ml of sulphuric-phosphoric acid mixture, and dilute to about 250 ml, washing down the sides of the flask. Add three to four drops of sodium diphenylamine sulphonate indicator solution and titrate slowly with standard potassium dichromate solution stirring continuously until the green colour begins to darken. Continue the titration slowly till a drop of the dichromate solution produces a stable violet-blue colouration.

6.3.3 Make a blank determination following the same procedure and using the same amounts of all reagents, but without the sample.

6.4 Calculation

$$\text{Iron, percent} = \frac{(A - B)\,C}{D} \times 5{\cdot}585$$

where

A = volume in ml of standard potassium dichromate solution required for the test solution,

B = volume in ml of standard potassium dichromate solution required to titrate the blank,

C = normality of the standard potassium dichromate solution, and

D = weight in g of the sample taken.

7. DETERMINATION OF MANGANESE BY THE PERSULPHATE-ARSENITE METHOD

7.1 Outline of the Method — Manganese in the solution of the sample is oxidized to permanganic acid and determined after oxidation with potassium persulphate. The permanganic acid is then titrated with standard arsenite solution.

7.2 Reagents

7.2.1 *Mixed Acids* — Mix slowly 100 ml of concentrated sulphuric acid, with 525 ml of water, cool and add 125 ml of phosphoric acid and 250 ml of concentrated nitric acid.

7.2.2 *Silver Nitrate Solution* — 3 g of silver nitrate per litre.

7.2.3 *Ammonium Persulphate Solution* — 250 g per litre, freshly prepared.

7.2.4 *Standard Sodium Arsenite Solution* — (1 ml = 0·000 3 g of Mn). Standardize against a sample of known manganese content having a composition similar to that of the material to be analysed as under **7.3**.

7.3 Procedure

7.3.1 Transfer 0·5 to 2 grams of the accurately weighed sample, containing less than 0·01 g of manganese, to a 300-ml beaker and dissolve in 30 ml of the mixed acids. When solution is complete, heat gently to expel brown fumes.

7.3.2 Add 50 ml of hot water, 10 ml of silver nitrate solution and 10 ml of ammonium persulphate solution. Heat to boiling and boil for one to two minutes.

7.3.3 Cool to 25°C or below, add 50 ml of cold water and titrate rapidly with the arsenite solution until the purple colour disappears and the clear yellow-green colour is developed.

7.4 Calculation

$$\text{Manganese, percent} = \frac{A \times B}{C} \times 100$$

where

A = volume in ml of the sodium arsenite solution required for titration of the sample,

B = manganese equivalent in g/ml of the sodium arsenite solution, and

C = weight in g of the sample taken.

8. DETERMINATION OF ZINC BY THE EDTA METHOD

8.1 Outline of the Method — After the removal of copper and lead, zinc is precipitated as sulphide, filtered, dissolved in hydrochloric acid and then titrated with EDTA solution.

8.2 Reagents

8.2.1 *Dilute Nitric Acid* — 1 : 1 (*v/v*).

8.2.2 *Dilute Ammonium Hydroxide* — 1 : 1 (*v/v*).

8.2.3 *Methyl Orange* — Dissolve 0·1 g of methyl orange in 100 ml of water. Filter, if necessary.

8.2.4 *Dilute Sulphuric Acid* — 1 : 1 (*v/v*).

8.2.5 *Hydrogen Sulphide* — gas.

8.2.6 *Dilute Hydrochloric Acid* — 1 : 1 (*v/v*).

8.2.7 *Sodium Hydroxide Solution* — 1 : 1 (*v/v*).

8.2.8 *Buffer Solution* — Dissolve 54 g of ammonium chloride in water. Add 30 ml of ammonium hydroxide and dilute to one litre.

8.2.9 *Standard Sodium Ethylenediamine Tetra-Acetate Solution* — Dissolve the salt (3·5 to 18·5 g) in a litre of water and standardize by the procedure given under **8.3** against a similar alloy.

8.2.10 *Eriochrome Black-T Indicator Solution* — Dissolve 0·4 g of the sodium salt in a mixture of 20 ml of ethyl alcohol and 30 ml of triethanolamine.

8.3 Procedure

8.3.1 Dissolve one gram of the accurately weighed sample, depending upon the amount of zinc, in dilute nitric acid and remove copper and lead as described under **4.4**.

8.3.2 Cool and neutralize the solution with dilute ammonium hydroxide using methyl orange as indicator. Dilute to 400 ml and add one millilitre of dilute sulphuric acid for each 100 ml of solution so that the final acidity of the solution is 0·01 N. Through the solution at room temperature, pass a rapid stream of hydrogen sulphide for at least 30 minutes. Allow the precipitate to settle and filter through close-texture ashless paper and wash thoroughly with cold water to remove all traces of solution salts.

8.3.3 Transfer the paper to the original beaker in which hydrogen sulphide precipitation was done. Dissolve in hot dilute hydrochloric acid avoiding large excess of the acid and boil off hydrogen sulphide. Cool and neutralize the solution with sodium hydroxide solution. Add 25 ml of the buffer solution and 5 to 10 drops of the eriochrome black-T indicator solution and titrate with EDTA solution to pure blue end point.

8.4 Calculation

$$\text{Zinc, percent} = \frac{A \times B}{C} \times 100$$

where

A = volume in ml of standard EDTA solution used,

B = zinc equivalent in g/ml of the standard EDTA solution in ml, and

C = weight in g of the sample taken.

9. DETERMINATION OF CARBON (TOTAL) BY THE DIRECT COMBUSTION (GRAVIMETRIC) METHOD

9.1 Outline of the Method — The sample is burnt in a stream of pure oxygen, and the resulting carbon dioxide is absorbed in soda asbestos after removal of the contaminants. The increase in weight of the absorbent is proportional to the carbon content of the sample.

9.2 Apparatus — The assembly of apparatus is shown in Fig. 2.

9.2.1 *Source of Oxygen Supply* — gas holder (*A*) capacity 8 to 10 litres containing 99·5 percent oxygen, free from carbonaceous matter connected by rubber tubing with the gas purifying train. The gas holder should be filled up before starting the operation.

9.2.2 *Oxygen Purification Train* — consists of Arnold bottles (*B*) and (*C*), the latter containing concentrated sulphuric acid, the exit bulb of which is packed with glass wool and another absorption bottle (*D*) containing soda asbestos which passes through IS Sieve 1·40 mm (width of aperture 1·40 mm) but is retained on IS Sieve 500 micron (width of aperture 0·500 mm) (*see* IS : 460-1962*), and "anhydrone" in layers, connected

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*Specification for test sieves (*revised*).

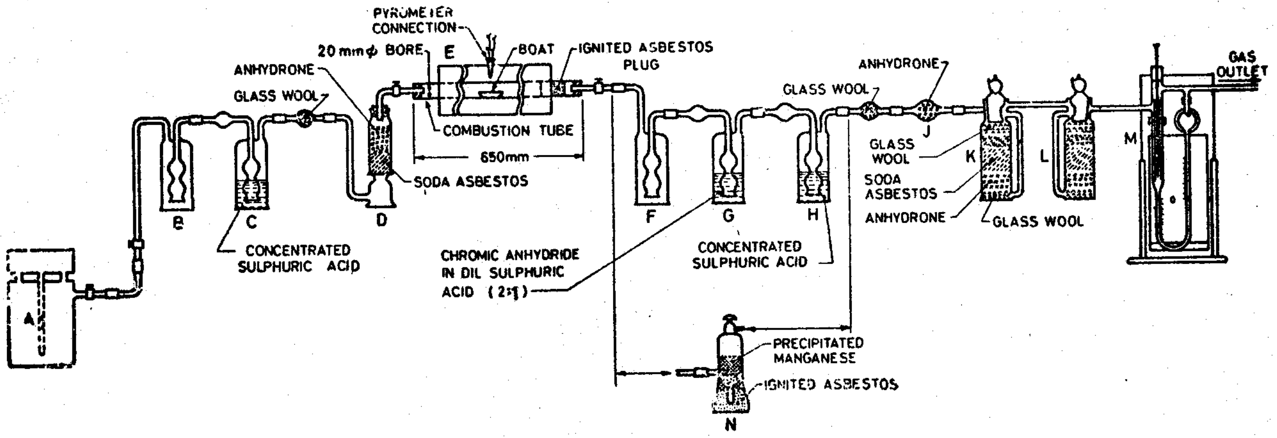

Fig. 2 Apparatus for the Determination of Carbon (Total) by the Direct Combustion (Gravimetric) Method

in series between the gas holder and the inlet end of the combustion tube. A layer of about 12 mm of anhydrone is placed on top for removing moisture in the gas and the soda asbestos removes carbon dioxide in the gas.

9.2.3 *Furnace* — a horizontal tube furnace (*E*) heated to about 1 350°C by electricity.

9.2.4 *Combustion Tube* — A combustion tube approximately 650 mm long and of 20 mm inner diameter, made of fused silica, fire-clay or any other suitable material should be used. In the exit end of the tube an ignited asbestos plug 75 mm long is placed lightly to retain ferric oxide carried over by the gas stream.

9.2.5 *Absorption Train* — consists of an Arnold bottle (*F*) to prevent back suction, a gas absorption bottle (*G*) filled with chromic anhydride in dilute sulphuric acid [2 : 1 (*v*/*v*)] to remove oxides of sulphur from the gas stream, a bottle (*H*) containing about 10 ml of concentrated sulphuric acid to remove most of the moisture from exist gas. The exit end of this bottle is filled with glass wool to remove sulphuric acid mist, one tube (*J*) containing "anhydrone" or any other suitable desiccant and carbon dioxide absorption bottle (*K*) (80 ml capacity) containing a layer of soda asbestos or ascarite, which should be uniformly graded and evenly packed with a layer of anhydrone on the top, all connected in series with the exit end of the combustion furnace and the atmosphere. The fillings in (*K*) are held in position by small plugs of glass wool. A bottle (*L*), packed similarly to bottle (*K*) acts as a guard against atmospheric gases. Its exit end is attached to a flowmeter (*M*). Bottles (*F*), (*G*) and (*H*) may be replaced by a Midvale or Nesbitt bulb (*N*) containing precipitated manganese dioxide over ignited asbestos.

9.3 Reagents

9.3.1 *Concentrated Sulphuric Acid*—sp gr 1·84 (conforming to IS : 266-1961*).

9.3.2 *Dilute Sulphuric Acid* — 2 : 98 (*v*/*v*).

9.3.3 *Chromic-Sulphuric Acid Solution* — Saturate 100 ml of dilute sulphuric acid (2 : 1) with chromic anhydride.

9.3.4 *Manganese Sulphate* — solid.

9.3.5 *Concentrated Ammonium Hydroxide* — 20 percent.

9.3.6 *Ammonium Persulphate Solution* — 25 and 22·5 percent (*w*/*v*).

9.3.7 *Precipitated Manganese Dioxide* — Dissolve 200 g of manganese sulphate ($MnSO_4$, $4H_2O$) in 2 500 ml of water, add concentrated ammonium hydroxide until ammoniacal, followed by 1 000 ml of freshly prepared ammonium persulphate solution (22·5 percent) and heat to boiling. Boil for 10 minutes, adding more of concentrated ammonium hydroxide to maintain the ammoniacal condition. Further addition of solutions of ammonium persulphate and ammonium hydroxide may be required until precipitation is judged to be complete. Discontinue boiling and allow the precipitate to settle; wash by decantation 6 to 8 times with 500 to 600 ml portions of water, allowing the precipitate to settle thoroughly between washings. Finally wash 2 to 3 times by decantation with 500 to 600 ml portions of dilute sulphuric acid. Transfer the precipitate to a Buchner funnel and wash with hot water until free from sulphates. Dry the residue at 105° to 110°C, grind to pass through IS Sieve 850 micron (width of aperture 0·850 mm) but retain on IS Sieve 710 micron (width of aperture 0·710 mm) (*see* IS : 460-1962*) and again dry thoroughly at 105° to 110°C.

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*Specification for sulphuric acid (*revised*).

9.3.8 *Soda Asbestos* — It should be graded to pass through IS Sieve 140 micron (width of aperture 1·40 mm) but retain on IS Sieve 500 micron (width of aperture 0·500 mm) (*see* IS : 460-1962*).

9.3.9 *Anhydrone or Magnesium Perchlorate* $Mg(ClO_4)_2$ — The supply bottle should be well stoppered.

9.3.10 *Lead Foil* — This should be of assay grade and about 0·125 mm in thickness.

9.3.11 *Magnesite Brick Powder* — Magnesite brick powder which has passed through IS Sieve 500 micron (width of aperture 0·500 mm) shall be used for spreading in the boat on which the sample is to be placed before combustion. This powder shall be calcined in the open muffle furnace prior to use, in order to eliminate any carbonaceous matter.

9.4 Procedure

9.4.1 Heat the furnace to a temperature between 1 200° to 1 300°C. Determine the temperature by a standard thermocouple type pyrometer. Before starting an analysis, test the apparatus for any leaks. Pass a slow stream of oxygen for about 15 minutes through the whole train of the apparatus, and then weigh the carbon dioxide absorption bulb. After taking the first weight, connect it back to the apparatus, pass oxygen for 15 minutes and weigh again. If constant weight is obtained, the apparatus is ready for use.

9.4.2 Transfer 2 g of an accurately weighed sample into a previously ignited combustion boat made of either porcelain refractory clays, or alumina and of dimensions about 120 × 20 × 15 mm with walls as thin as possible. Cover the sample with lead foil (1·5 g twice folded). Before placing the sample in the boat, sprinkle in the bottom of the boat some burnt magnesite brick powder which has been tested by the blank

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*Specification for test sieves (*revised*).

run (*see* **9.4.4**). Insert the boat quickly into the hot zone of the furnace for abuot a minute so that the boat attains the temperature of the furnace and pass oxygen at the rate of 900 to 1 000 ml/minute. Continue the combustion for 15 minutes at a temperature of 1 200° to 1 300°C.

9.4.3 Close the absorption bulb and stop the flow of oxygen. Place the bulb in the balance case and allow to stand for 10 minutes, open momentarily and weigh. The increase in weight is the weight of carbon dioxide.

9.4.4 Make a blank determination on a covered but blank boat by the same procedure.

9.5 Calculation

$$\text{Carbon, percent} = \frac{(A - B) \times 27{\cdot}29}{C}$$

where

A = weight in g of carbon dioxide from the sample,

B = weight in g of carbon dioxide from the blank, and

C = weight in g of the sample taken.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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